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MORMON MOUNTAINS G-E-M RESOURCES AREA

(GRA NO. NV-27)

TECHNICAL REPORT

(WSA NV 050-0161)

Contract YA-553-RFP2-1054

Prepared By

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Final Report

April 29, 1983

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EXECUTIVE SUMMARY

The Mormon Mountains Geology-Energy-Minerals (GEM) Resource Area (GRA) includes the following Wilderness Study Area (WSA): NV 050-0161.

The GRA is located in southeastern Lincoln County, Nevada, north of Interstate Highway 15.

The WSA includes most of the outcrop area of the Mormon Mountains. The Mormon Mountains consist of 300 to 600 million year old carbonate rocks thrust over the oldest rocks exposed in Lincoln County. The Mormon Mountains is an eroded dome with an exceedingly complex structure.

There are no known mineral deposits in the WSA, but there are occurrences and prospects. Metallic mineral occurrences include copper at the Whitmore mine along an apparent thrust contact, and an unknown commodity at the Iron Blossom claims associated with one of the small outcrop areas of volcanic rocks. Nonmetallic mineral occurrences include vermiculite in pegmatites on the west side of the range and quartzite and carbonate rocks throughout the range.

There are no patented claims in the WSA. Five unpatented lode claims are in the Iron Blossom group in the northern Mormon Mountains and one lode claim is at the site of the vermiculite occurrence on the west side of the range. There are literally hundreds of recent placer claims located in the alluvial fans along the southern flanks of the Mormon Mountains, reportedly for precious metals. Many of the claims are within the WSA boundary. Nearly all of the GRA has been leased for oil and gas, but there are no geothermal leases.

For metallic mineral resources the Whitmore mine area and Iron Blossom claim group have a moderate favorability with a low to moderate confidence level. The very southern portion of the WSA which is covered by the large group of placer claims, has a low favorability with a low confidence level. The lower plate older metamorphic and clastic rocks have a low favorability with a very low confidence level. The majority of the WSA which is carbonate rocks has a low favorability with a low confidence level and the alluvium in the WSA has a low favorability with a very low confidence level.

Uranium for the entire WSA has a low favorability with a low confidence level, and thorium has very low favorability with a very low confidence level. For nonmetallic mineral resources almost the entire WSA is considered to have a moderate favorability with a moderate confidence level and includes the pegmatites, sand and gravel, quartzite and carbonate units in the WSA. Oil and gas has a moderate to low favorability throughout

the WSA with a very low confidence level, while geothermal has a low favorability with a very low confidence level.

Recommendations for further work include more detailed geologic mapping of the WSA, and further investigation into purported mineralization on a large group of placer claims in the southern portion of the WSA.

I. INTRODUCTION

The Mormon Mountains G-E-M Resources Area (GRA No. NV-27) contains approximately 360,000 acres (1,400 sq km) and includes the following Wilderness Study Area (WSA):

WSA Name	WSA Number
Mormon Mountains	NV 050-0161

The GRA is located in Nevada within the Bureau of Land Management's (BLM) Caliente Resource Area, Las Vegas district. Figure 1 is an index map showing the location of the GRA. The area encompassed is near 37°00' north latitude, 114°25' west longitude and includes the following tonwships:

T 9 S, R 67-69 E
T 10 S, R 65-59 E
T 11 S, R 65-69 E
T 12 S, R 65-69 E
T 13 S, R 65-69 E

The areas of the WSA are on the following U. S. Geological Survey topographic maps:

7.5 minute:

Vigo	Carp
Toquop Gap	Rox
Moapa Peak, NW	Rox, NE
Davidson Peak	Rox, SE
Moapa Peak	Moapa, SE

The nearest town is Moapa which is located approximately eight miles south of the GRA. Access to the area is via Interstate 15 to the south. Access within the area is via unimproved light duty and dirt roads scattered throughout the GRA.

Figure 2 outlines the boundaries of the GRA and the WSAs on a topographic base at a scale of 1:250,000.

Figure 3 is a geologic map of the GRA and vicinity, also at 1:250,000. At the end of the report following the Land Classification Maps is a geologic time showing the various geologic eras, periods and epochs by name as they are used in the text, with the corresponding age in years. This is so that the reader who is not familiar with geologic time subdivisions will have a comprehensive reference for the geochronology of events.

This GRA Report is one of fifty-five reports on the Geology-Energy-Minerals potential of Wilderness Study Areas in

the Basin and Range province, prepared for the Bureau of Land Management by the Great Basin GEM Joint Venture.

The principals of the Venture are Arthur Baker III, G. Martin Booth III, and Dennis P. Bryan. The study is principally a literature search supplemented by information provided by claim owners, other individuals with knowledge of some areas, and both specific and general experience of the authors. Brief field verification work was conducted on approximately 25 percent of the WSAs covered by the study.

This GRA and the included WSA was field checked during early December, 1982.

One original copy of background data specifically applicable to this GEM Resource Area Report has been provided to the BLM as the GRA File. In the GRA File are items such as letters from or notes on telephone conversations with claim owners in the GRA or the WSA, plots of areas of Land Classification for Mineral Resources on maps at larger scale than those that accompany this report is such were made, original compilations of mining claim distribution, any copies of journal articles or other documents that were acquired during the research, and other notes as are deemed applicable by the authors.

As a part of the contract that resulted in this report, a background document was also written: Geological Environments of Energy and Mineral Resources. A copy of this document is included in the GRA File to this GRA report. There are some geological environments that are known to be favorable for certain kinds of mineral deposits, while other environments are known to be much less favorable. In many instances conclusions as to the favorability of areas for the accumulation of mineral resources, drawn in thse GRA Reports, have been influenced by the geology of the areas, regardless of whether occurrences of valuable minerals are known to be present. This document is provided to give the reader some understanding of at least the most important aspects of geological environments that were in the minds of the authors when they wrote these reports.

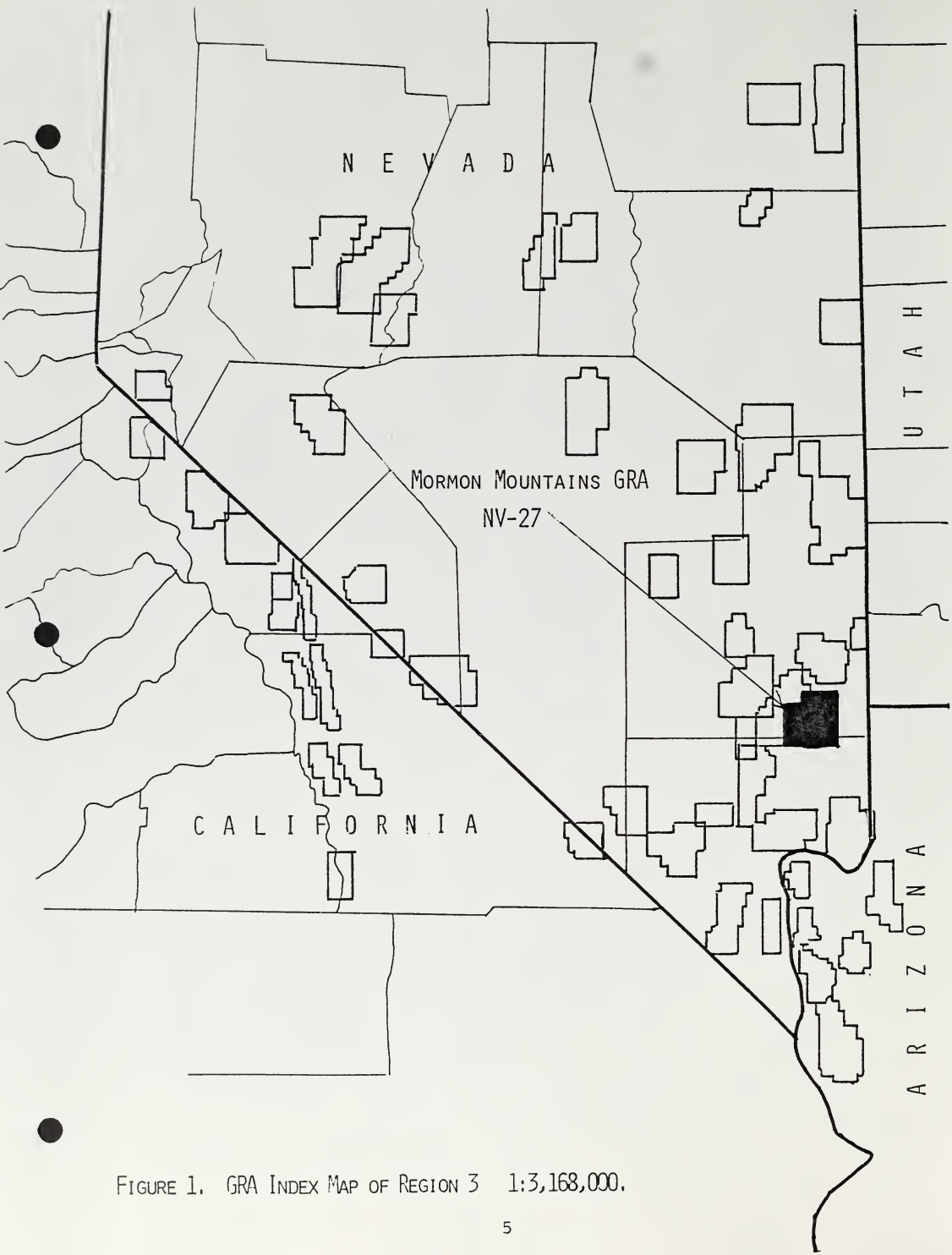
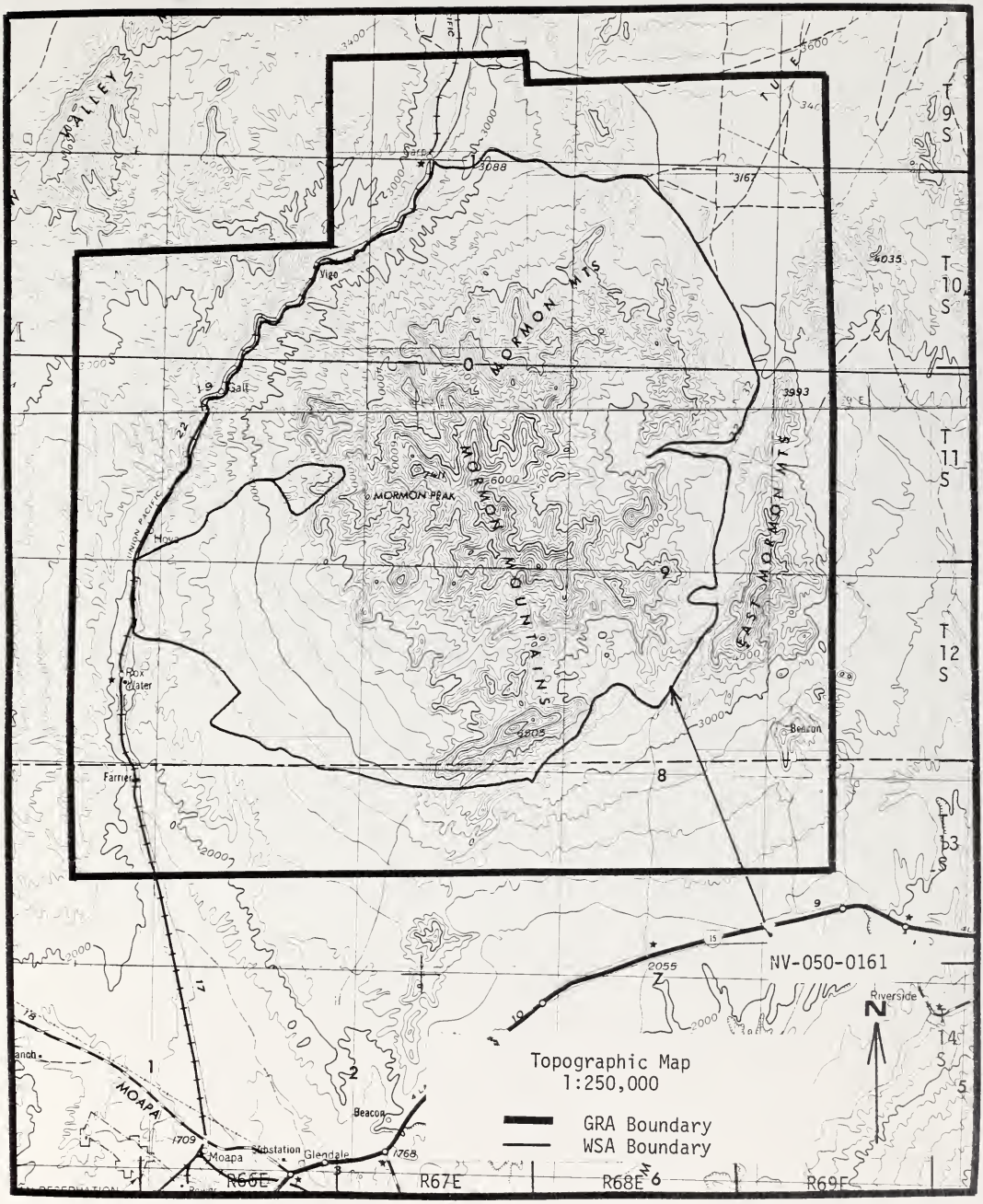


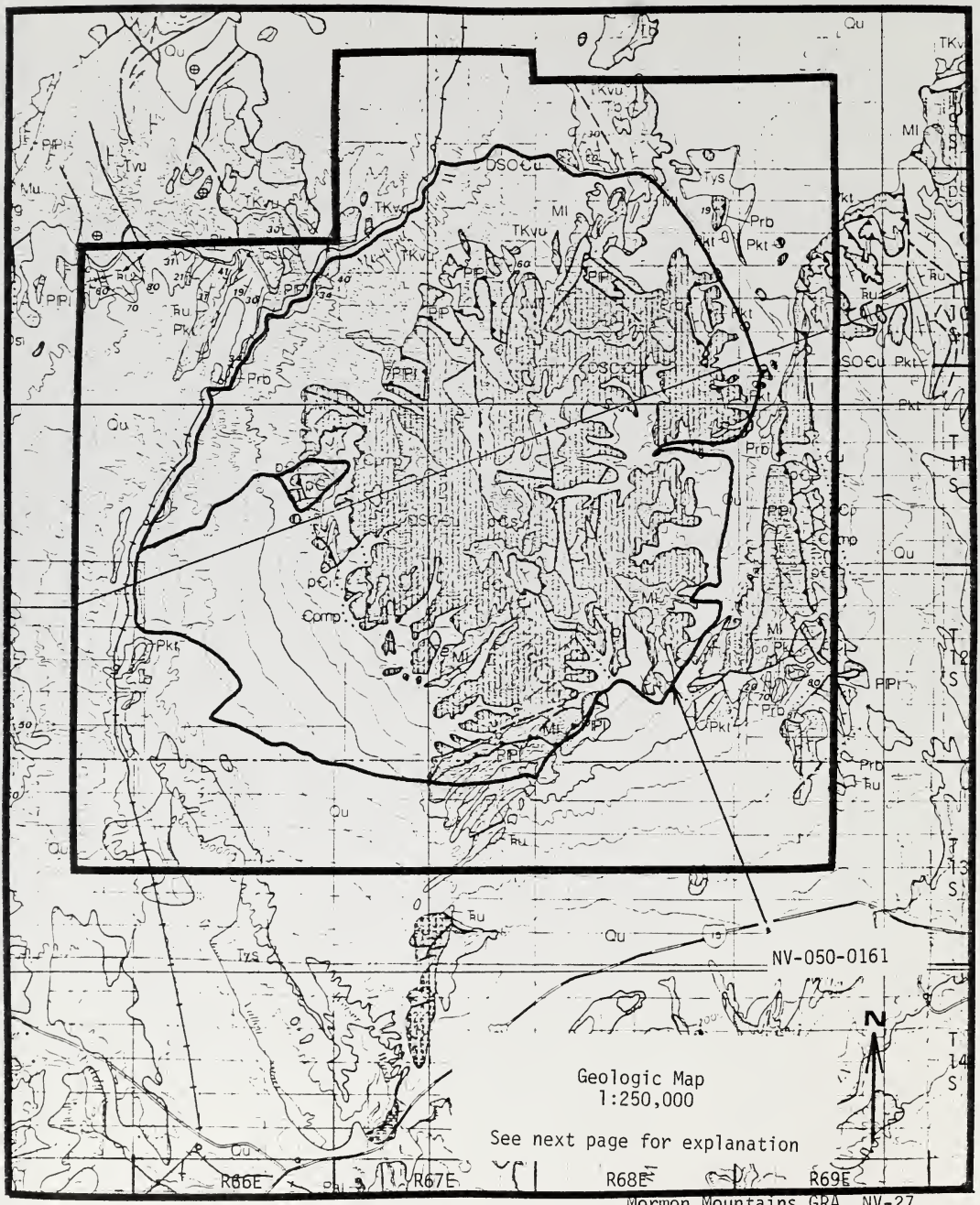
FIGURE 1. GRA INDEX MAP OF REGION 3 1:3,168,000.



Caliente and Las Vegas Sheets

Mormon Mountains GRA NV-27

Figure 2



Howard (1978)

Mormon Mountains GRA NV-27

Figure 3

Mississippian, Lower (Ml): *Includes Monte Cristo and Rogers Spring Limestones in Clark County, Joana, Mercury and Bristol Pass Limestones in Lincoln County; and Joana Limestone elsewhere.*

Mississippian-Devonian, Undfiferentiated (MDu) *Includes Rogers Spring Limestone and Muddy Peak Limestone in parts of Clark County Joana Limestone and Pilot Shale in Elko County, Pilot Shale, Joana Limestone, Chainman Shale and Diamond Peak Formation in Eureka and White Pine Counties.*

Mississippian-Devonian, Pilot Shale (MDp): *Shown in combination with other Mississippian Formations in Clark, Elko, parts of Lincoln, Eureka and White Pine Counties.*

Devonian-Cambrian, Undifferentiated (DSO€u): *Undivided limestone and dolomite occurring in Lincoln County.*

Devonian-Ordovician, Undifferentiated (DSO): *Dolomites in Elko and Nye Counties.*

Devonian Upper (Du): *Primarily Devils Gate and Guilmette Formations. Also includes Sevy and Simonson dolomites in parts of White Pine County. Contains Guilmette, Devils Gate, Simonson and Sevy in Elko County under the heading of Dgu. Local symbols used where possible.*

Devonian Dolomite (Dd): *Alternating light to dark gray fine to coarse crystal dolomite. Included with other Silurian and Devonian sediments in North Central Nevada and parts of Utah. Grouped with Sevy Dolomite in parts of Clark, Elko, Eureka, Nye, and White Pine Counties.*

Sevy Dolomite (Dse): *Very light colored, dense, distinctly bedded unfossiliferous dolomite. Combined with other Devonian and Silurian sediments in parts of North Central Nevada and Utah and with the Simonson Dolomite in parts of Clark, Elko, Eureka, Nye and White Pine Counties.*

Silurian-Devonian Dolomites, combined (SDd): *Also includes the Bird Spring Formation, Keystone Thrust, Arrow Canyon Formation, Mississippian Limestone, Monte Cristo Limestone, Joana Limestone, Mississippian-Devonian Chainman Shale, Diamond Peak Formation, Devils Gate Limestone, Woodpecker Limestone, Oxyoke Canyon Sandstone and Nevada Formation in Nye County; Nevada Formation and Devils Gate Limestone in Eureka County and the Nevada Formation in White Pine County. Local symbols are used where possible.*

Devonian Western Facies (Dw): *A portion of the western allochthonous assemblage. Includes Woodruff Formation and Slaven Chert in Eureka County and siliceous siltstone in the Cockalorum Wash area of Nye County.*

Silurian, Undifferentiated (Su): *Includes Lone Mountain and Laketown Dolomites throughout the mapping area, the Elder Sandstone and Fournile Canyon formation in Eureka County, and the Roberts Mountain formation in Nye County. In White Pine County, the Silurian deposits are grouped with the upper Ordovician sediments under the heading of Silurian-Ordovician, Undifferentiated (SOu).*

Upper Ordovician, Undifferentiated (Ou): *Includes Ely Springs Dolomite, Lone Mountain Dolomite, Lehman Formation, Eureka Quartzite, Hanson Creek Formation, Antelope Valley Limestone, Ely Springs Dolomite, Eureka Quartzite, Pogonip Group, Valmy Formation, Vinini Formation, Comus Formation, Copenhagen Formation, Palmetto Formation, Goodwin Limestone, Juniper Canyon Formation, Barrel Spring Formation, Fish Haven Dolomite and the Hanson Creek Formation. Local symbols are used where possible. Listed as Ordovician, Undifferentiated (Ou) in parts of North Central Nevada. In Clark County, Ely Springs Dolomite has been divided from the rest of Oep by the author. The Eureka Quartzite and Pogonip Group are grouped with Silurian sediments under the heading Silurian-Ordovician, Undifferentiated (SOu) in Elko County.*

Ordovician, Eureka Quartzite (Oe) *Light colored vitreous quartzite and hard sandstone. Also includes the Swan Peak Quartzite in parts of Utah. In Clark County, the Eureka Quartzite has been separated from Oep by the author. In parts of North Central Nevada, the Eureka Quartzite has been grouped with other Ordovician sediments under the heading of Ou. In White Pine County, the Eureka Quartzite has been grouped with the Pogonip Group under the heading of*

Ordovician, Pogonip Group (Op): *Limestone, silty limestone, shale and interformational conglomerates. In Clark County, the Pogonip Group has been separated from Oep by the author. Includes the Garden City Limestone in parts of Utah. In White Pine County, the Pogonip Group is grouped the Eureka Quartzite under the heading of Ol.*

Ordovician, Undifferentiated (Ou): *Includes the Pogonip Group, Ely Springs Dolomite, Eureka Quartzite and Comus Formation in North Central Nevada.*

Ordovician, Vinini Formation (Ovi): *Part of the western allochthonous assemblage. Includes Valmi Formation in parts of North Central Nevada. Local symbols are used where possible.*

Cambrian-Ordovician, Undifferentiated (O€u): *Occurs in Elko, Eureka, Nye and White Pine Counties as shale and limestone and is usually so identified when metamorphosed to phyllite. Includes the Tennessee Mountain Formation in Elko County, Board Canyon, Sequence in North Central Nevada, Windfall Formation in Nye County and the lower Ordovician and post-Dunderberg Shale in the Schell Creek Range of White Pine County. In some parts of Nye County, O€u is metamorphosed to slate and marble instead of phyllite.*

Cambrian, Upper and Middle (€u): *Primarily limestones, dolomites, shales and quartzites. Includes Edgemont and Peak Limestones in Elko County; Highland Peak formation, Patterson Pass Shale, Poli Canyon Limestone, Chisholm Shale and Lyndon Limestone, member of the Chisholm Shale in Lincoln County, Harmony Formation, Preble Formation, Pioche Shale, Eldorado Dolomite, Geddes Limestone, Secret Canyon, Hamberg, Dole and Dunderberg Shales, Windfall Formation, and Scott Canyon Formation in North Central Nevada, Galt Formation, Dunderberg Shale, Tybo Shale and Emigrant Formation in Nye County, Notch Peak Formation, Dunderberg Shale, Orr Formation, Weeks Formation, Marjum Formation, Wheeler Shale, Swasey Formation, Whirlwind Formation, Dome Limestone, Howell Formation and Tatow Formation in Utah, and Corset Spring Shale, Notch Peak Limestone, Dunderberg Shale and Windfall Limestone in White Pine County. Metamorphosed to schist in Elko County.*

Cambrian, Lower (€pmp): *Primarily Prospect Mountain Dolomite and Pioche Shale. Also includes Tapeats Sandstone, Wood Canyon Formation, Lyndon Limestone, Chisholm Shale and Carrera Formation in Clark County; Sterling Quartzite and Wood Canyon Formation in parts of Lincoln County; Busby Quartzite in the Gold Hill area of Utah and the Stella Lake Quartzite in White Pine County.*

Precambrian

Precambrian Sediments (p€s): *Includes the Johnnie Formation, Sterling Quartzite and some metamorphics in Clark County; Johnnie Formation and lower units of Prospect Mountain Quartzite in Lincoln County; McCoy Creek Group in Elko County, and the McCoy Creek Group excluding the Stella Lake Quartzite in White Pine County.*

Precambrian Intrusives (p€i): *Includes the Gold Butte Granite in Clark County and other undifferentiated igneous and metamorphic rocks, primarily granites and pegmatites.*

EXPLANATION

Cenozoic Sediments

...ternary, Undifferentiated (Qu): *Includes all sedimentary rocks ... surface exposures of recent playa deposits, dune sands, lake beds ... eolian deposits and younger as well as certain older exposures of ... ...ls and other alluvium associated with pediments and mountain ...*

... Sediments (Tys): *Sedimentary rocks of Miocene ... ...ng older lake beds of the Muddy Creek Formation ... ...rmation in Lincoln and Clark Counties; the Muddy Creek Formation in Southwestern Utah, pre-Quaternary sediments in the Virgin River Valley, and sediments associated with ash-flow tuffs near Antelope Summit in White Pine County.*

Tertiary Sediments, Undifferentiated (Tsu): *Primarily Miocene and ... Oligocene deposits including tuffaceous sediments interbedded ... ...ic tuffs, the Horse Camp Formation and various unidentified tuffaceous shales and diatomites in Nye County; intravolcanic tuffaceous and clastic sedimentary rocks in Lincoln and Nye Counties, and conglomerates and limestones of uncertain age in the Egan Range and the Cricket Mountains of Utah.*

... (Oligocene-Eocene) (Tos): *Includes the Sheep Pass Formation ... ...in Nye County, the Gilmore Gulch Formation in Nye ... ...lacustrine limestones in southern Lincoln County, ...conglomerates, tuffaceous and clastic sedimentary rocks, ...stones, cherts, claystones, silts, carbonaceous shales and oil shales in Elko County, and older limestones of the Illipah area and the Harkless Canyon Formation of the Schell Creek and Grant Ranges in White Pine County.*

... (Tb): *Basalt, andesite and latite of Quaternary or ... ...ertiary age in Nye County.*

Tertiary Basalt (Tb): *Intermediate and basaltic lavas including, the ... ...fication Basalt Member of the Muddy Creek Formation in Clark County; basalt flows, basaltic cinder, tuff and lava cones which are included in parts of the Banbury Formation and latite flows in Elko County; basalt flows and dikes in Lincoln County; and silicic basalt ... of various ages in North Central Nevada, and basalt and ... ...in Southwestern Utah.*

Volcanics, Undifferentiated (Tvu): *Early to late Tertiary ... ...rocks ranging in composition from silicic to intermediate; ... ...rily rhyolites, dacites, quartz latite flows, ignimbrites and pyroclastics of widespread occurrence. These rocks are listed under various subdivisions in Elko, Lincoln, and Nye Counties, North Central Nevada and Southwestern Utah.*

Tertiary Oligocene Volcanics (Tvo): *Pre-Miocene volcanic rocks lithologically similar to the Tertiary Volcanics, Undifferentiated (Tvu). Listed ... ...various subdivisions in Nye County.*

Intrusives (TKgr): *Occurred from mid-Jurassic through late Tertiary. Widespread intrusions ranging in composition from granitic through ... ...basic and in texture from holocrystalline to porphyritic.*

Mesozoic Sediments

Tertiary-Cretaceous Sediments (TKsu): *Continental sediments consisting of conglomerates, clastics, tuffs and limestones. Includes the Gale Hills Formation and the Overton Conglomerate.*

Cretaceous Sediments (Ks): *Chiefly non-marine siltstone, shale, conglomerate and limestone. Includes lower Gale Hills Formation, Thumb Formation, Baseline Sandstone, Willow Tank and Newark Canyon Formations.*

Jurassic (Ju): *Eolian cross-bedded sandstone in Utah, volcanically derived sediments, ash flows and basic lava flows in northern Elko County. Includes Navajo Sandstone, Aztec Sandstone, Frenchie Creek Formation and Bayer Ranch Formation.*

Jurassic-Triassic (JTu): *Includes Nugget and Aztec Sandstones and Chinle Formation of southern Nevada.*

Triassic (Tu): *Shallow marine sedimentary rocks including Chinle, Shinarump, Thaynes and Moenkopi Formations in the west and continental to shallow marine sediments in the east.*

Mesozoic Volcanics

Tertiary-Cretaceous Volcanics (TKvu): *Occur in Lincoln County where it covers wide areas of the Clover, Del Mar, Wilson Creek, White Rock and Mahogany Mountains.*

Paleozoic Sediments

Permian, Undifferentiated (Pu): *Shallow marine intertidal and continental sediments. Includes Gerster Formation, Plympton Formation, Kaibab Limestone, Park Group Formation, Coconino Sandstone, Arcturus Formation, Riepetown Formation, Rib Hill Sandstone, Riepe Springs Formation, Carbon Ridge Formation and Loray Limestone. With the exception of parts of White Pine County, local symbols are used to identify all Permian outcrops. In White Pine County, local symbols are used except for the Park City Group which is grouped with the Arcturus and Rib Hill Sandstones (Par). To avoid confusion, non-standard symbol used for Permian in Utah has been replaced with the standard "P".*

Pennsylvanian-Permian (PP): *Marine sandstone and limestone (dolomatized in places). Includes Rib Hill Sandstone, Riepe Spring Limestone and Ferguson Mountain Formation in southern White Pine County; Strathearn Formation, Buckskin Mountain Formation, Indian Flat Formation and Carlin Canyon Formation in Eureka County; Pablo Formation in Nye County; and Oquirrh Formation or group in Utah. Local symbols are used where possible.*

Pennsylvanian, Undifferentiated (Pu): *Includes Ely Limestone, Moleen and Tomera Formations. To avoid confusion, the non-standard symbol used for Pennsylvanian in Utah has been replaced by "P".*

Mississippian Upper (Mu): *Includes Diamond Peak and Bird Spring Formations, Callville Limestone, Scotty Wash Formation, Ochre Mountain Limestone and Manning Canyon Shale in parts of Clark County. Chainman Shale is combined with Diamond Peak Formation in some parts of Utah.*

Mississippian, Chainman Shale (Mc): *Includes Mountain City Formation in Elko County and Eleana Formation in Nye County.*

II. GEOLOGY

The Mormon Mountains GRA includes the Mormon Mountains, the East Mormon Mountains, and portions of the adjoining valleys. WSA 050-0161 contains the Mormon Mountains a subcircular mountain mass 15 to 20 miles across.

The Mormon Mountains are an exhumed dissected dome whose Cenozoic cover has been stripped away by tributaries to the Colorado River (see Figure 3). Precambrian igneous and metamorphic rocks exposed in two windows in the WSA are overlain by thrust sheets of Paleozoic marine sediments. The structure is extremely complex and not fully understood by former researchers of the area.

The East Mormon Mountains are a high, narrow, east-tilted, north-striking fault block bounded on the south by a major northeast-striking, transcurrent fault which may extend across the southern boundary of the Mormon Mountains.

Most of the following geological description is taken from the Lincoln County Geological report by Tschanz and Pampeyan, 1970.

1. PHYSIOGRAPHY

The Mormon Mountains GRA lies within the Basin and Range province, mostly in southern Lincoln County with the southern boundary extending several miles into northern Clark County. WSA NV 050-0161 contains the Mormon Mountains, a subcircular mountain mass 15-20 miles across.

The Mormon Mountains are an exhumed broad subcircular dissected dome whose Cenozoic cover has been removed by erosion. Precambrian igneous and metamorphic rocks are exposed in the center and along the west and southeast sides of the dome. Cambrian-Devonian carbonate formations have been locally thrust over the Precambrian rocks. Thrusts have also been locally defined in the northern and southern fringes of the dome.

The East Mormon Mountains are a high, narrow, east-tilted, north-striking, fault block bounded on the south by a major northeast-striking transcurrent fault.

The highest point in the study area is Mormon Peak with an elevation of 7,411 feet, with the lowest elevations along Meadow Valley Wash of less than 2,000 feet. Drainages radiate in all directions discharging into the surrounding valley washes which empty into the Colorado River.

2. ROCK UNITS

The oldest rock units found in the GRA are Precambrian igneous and metamorphic rocks which consist of granite, pegmatite, amphibolite and gneiss. These basement rocks crop out for four miles along the west side of the Mormon Mountains in a small window in the central part of the range, and for six miles along the eastern side of the East Mormon Mountains. Lower Cambrian Prospect Mountain Quartzite, and Pioche Shale are exposed in these same windows along with the Precambrian rocks. These Precambrian rocks are the oldest rocks exposed in Lincoln County.

Devonian to Cambrian undifferentiated limestone and dolomite has been thrust over the above older rocks and also over Permian red beds and Kaibab limestone near the south end of the Tule Desert. This early Paleozoic carbonate sequence belongs to the thin marginal shelf facies of the miogeosyncline. These rocks have not been differentiated because the distinctive units of the Eureka Quartzite, Ely Springs Dolomite, and Laketown Dolomite are absent.

The Lower Mississippian Monte Cristo limestone, crops out throughout the study area, and lies unconformably over the Devonian-Cambrian carbonate rocks. All five carbonate members of the Monte Cristo limestone, with a total thickness of about 900 feet, can be recognized in the Mormon Mountains.

Undivided Permian and Pennsylvanian limestone and sandstone were deposited next. These rocks are found on the north and south fringes of the Mormon Mountains and in a north-south trending fault block in the Eastern Mormon Mountains.

Red beds were then deposited during the Lower Permian. In the northeastern part of the Mormon Mountains about 200 feet of pink and brown quartzite of this formation are exposed beneath a thrust. The undivided Toroweap Formation and Kaibab limestone commonly form a conspicuous double cliff that is separated by nonresistent beds. The lower unit, the Toroweap, consists of mudstone and limestone. The overlying Kaibab limestone has a lower member of light gray cliff-forming limestone and an upper member of thin-bedded limestone and dolomite.

Undifferentiated Tertiary volcanics ranging in composition from rhyolite to basalt were deposited over the older sediments. These volcanics are predominantly an ignimbrite series that consists of welded tuffs, pumice, tuff breccias, flows and perlitic rocks. These volcanics are found along the fringe of the northern Mormon Mountains. Pliocene basalt was the next deposited formation. A small outcrop of this capping basalt is found near the northern border of the GRA.

Pliocene lake beds of the Muddy Creek Formation were the next formed units. These rocks, consisting of siltstone, clay and shale, crop out in Tule Desert and southeast of the East Mormon Mountains.

Unconsolidated Quaternary gravels and alluvium derived from nearby eroding highlands have been deposited in the surrounding valleys. These rocks are as much as 1,000 feet thick, and unconformably overlie the older lake beds.

3. STRUCTURAL GEOLOGY AND TECTONICS

The complex structural relationships in the Mormon Mountains are poorly understood partly because unconformities occur in the Paleozoic section (Tschanz and Pampeyan, 1970) and also probably because of the remoteness of the area.

The Mormon Mountains alone was uplifted approximately 3,000 feet in post-Mississippian time and is referred to as the Mormon Mountain Arch. Subsequently, tectonic forces related to the Cretaceous Laramide orogeny caused thrusting, folding and shearing of the sediments. It is postulated by Tschanz and Pampeyan (1970) that a detachment thrust may underlie the entire carbonate section in the dome-like Mormon Mountains. Throughout this area, younger rocks appear to be thrust over older rocks. The thrust surface, if present, probably follows one of the Cambrian shales. These postulated thrust surfaces appear to be a structural control for weak mineralization in at least one of the thrust windows.

An unconformity at the base of the Mississippian Monte Cristo Limestone may possibly be a thrust or bedding plane fault. It is also possible that these massive limestones are gravity block slides which have slid down the flanks of the uplifted Mormon Mountains (Tschantz and Pampeyan, 1970)

Other thrust plates and associated folds are exposed on the northwest flank and southern end of the Mormon Mountains. Basement rocks in the Eastern Mormon Mountains have been overridden by one or more thrust plates of Paleozoic carbonate rocks. The pre-Pennsylvanian upper plate rocks have overridden Precambrian and Lower Cambrian rocks on the west side of the range. Other minor thrusts are found in the southwest and northern fringes of this range.

Two right-lateral, northeast-trending, strike-slip faults cut the Paleozoic rocks in the southern part of the Eastern Mormon Mountains. The northernmost of these faults probably extends across the southern Mormon Mountains.

Basin and Range normal faults in the study area trend in a northerly direction. The East Mormon Mountains are bound on both sides by steeply dipping normal faults formed sometime during the Late Miocene-Early Pliocene. Normal faults also displace the Paleozoic sediments in the central Mormon

Mountains.

4. PALEONTOLOGY

The Mormon Mountains GRA is essentially one large fossil locality, especially that part underlain by the Pioche Shale (Cambrian) which contains an abundant trilobite fauna (Tschanz and Pampeyan, 1970; Wheeler, 1948). The Pioche Shale seems to be locally abundant on the west side of the Mormon Mountains, but reaches a thickness of over 200 feet on their eastern flank. A few olenellid trilobites are recorded from low in the section (Early Cambrian) and are replaced by agnostid trilobites higher in the section. A list of the total fauna is too long to include herein, but references in Tschanz and Pampeyan, 1970, give the sources for such a compilation.

The Monte Cristo Limestone, in the central part of the GRA contains abundant fossil echinoderms (pelmatozoans), brachiopods, corals, and mollusks.

Pennsylvanian and Upper Mississippian strata in the East Mormon Mountains and northern margin of Mormon Mountains are discontinuously fossiliferous.

5. HISTORICAL GEOLOGY

During the Paleozoic, marine carbonate sequences of the Cordilleran miogeosyncline were deposited over Precambrian igneous and metamorphic basement rocks.

Carbonate and clastic sequences were deposited during the Mesozoic; however, they were largely eroded away during the Laramide orogeny that began with uplift in Late Triassic time and culminated in thrust faulting in Cretaceous time.

Subsequently volcanism activated with the outpouring of ignimbrites during the Oligocene through early Pliocene.

Volcanism was followed by Basin and Range normal faulting during the Miocene-Pliocene. Pliocene lake deposits of the Muddy Creek Formation were deposited unconformably on all underlying rocks. Thick units of gravel and alluvium derived from the newly formed highlands accumulated in adjacent valleys.

III. ENERGY AND MINERAL RESOURCES

A. METALLIC MINERAL RESOURCES

1. Known Mineral Deposits

There are no known metallic mineral deposits in the GRA or the WSA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

There is one known copper prospect in the WSA. It is called the Whitmore mine located approximately in section 2, T 12 S, R 67 E on the Moapa Peak NW 15-minute topographic sheet and is shown in the Lincoln County report and is located on the Land Classification and Mineral Occurrence map near the end of this report.

This prospect was visited during the field investigation in December of 1982. There are both old and newer claim posts in the area, but according to the BLM records there are no current claims on the property. There are two shallow exploratory shafts and one inclined adit approximately 100 feet long, and all the workings appear to be in a thrust contact between lower plate Precambrian pegmatitic rocks and the upper plate Paleozoic carbonate units. The area in the vicinity of the Whitmore mine is a window through the upper thrust plate which exposes lower plate Precambrian and Cambrian units. There are minor amounts of copper oxide in shear zones parallel with the thrust contact. Another adit nearby was also along the thrust surface, and contained abundant iron oxide and associated alteration in the overlying limestone.

There were two other small prospects in the Cambrian units in this window with minor alteration and mineralization along stringers.

In the East Mormon Mountains to the east of the WSA is the Farnsworth-Jones manganese prospect and the Macbruson tungsten prospect in what Tschanz and Pampeyan (1970) call the Gourd Springs district, in T 11 S, R 69 E. The manganese oxides fill a steeply dipping fissure on a contact between Cambrian dolomitic limestone and altered Precambrian rock. Sixty tons of the manganese containing 10 to 22 percent manganese was mined in 1929. The Macbruson property contains disseminated scheelite in Precambrian amphibolite near large bodies of tourmaline-muscovite granite pegmatite.

The Iron Blossom lodes in Secs. 35 and 36 of T 10 S, R 67 E and Secs. 1 and 2 of T 11 S, R 67 E are for an unknown commodity. This is the area which has a shaft as

indicated on the Carp, Nevada 7.5-minute topographic sheet. These claims were not visited in the field due to access problems, but a review of aerial photographs of the area indicated there were minor workings near the base of what is mapped on the county report as undivided volcanics near the contact with the underlying carbonate rocks. In the color aerial photography there were areas that could possibly be alteration, but this would have to be confirmed in the field.

During our field verification a small mill was seen in Meadow Valley Wash near Rox. It appeared to have been recently active but it is unknown where the ore(?), which consists of a whitish clayey material, is coming from.

3. Mining Claims

Much of the alluvium in the southern portion of the GRA, including a part of the southwestern WSA, is completely covered by 20-acre placer claims for an unknown commodity. In excess of 80 square miles are staked this way, mostly in the last two years (see Claim Map). The local rumor is that these claims are for precious metals.

The other metallic mineral resources claims are discussed above in the prospect section. There are no patented mining claims in the WSA.

4. Mineral Deposit Types

The Whitmore copper prospect appears to be minor fissure fillings along a thrust surface. The manganese prospect is a fissure filling and the tungsten prospect is disseminated scheelite in Precambrian rock near pegmatites. The Iron Blossom prospect is unknown.

5. Mineral Economics

Not enough information is known concerning the metallic minerals in the GRA to make a good determination on the economics, but from the information available it appears that the deposits are small.

The largest use for copper is in electrical equipment and supplies and in smaller guage wire where its electrical conductivity is essential. It is also used in large quantities in applications where its corrosion resistance is important -- in housing, brass and bronze, sea-water corrosion resistant alloys and others. It is used also in ammunition, many chemicals, and in applications where its conductivity of heat is important. World production is about 7.5 million metric tons annually, of which the United States produces about 1.5 million tons, nearly

sufficient to satisfy domestic demand. Copper is a strategic metal. There are large reserves of copper ore in the world, and the United States has greater reserves and greater resources than any other country. United States demand is expected to nearly double by the year 2000, but reserves are thought to be sufficient to meet the demand. However, environmental problems of smelting copper may hinder production, and in times of low prices foreign producers tend to maintain full production for political reasons, while domestic producers tend to restrict production for economic reasons. These pressures on the domestic copper industry weaken its competitive capability on the world market. At the end of 1982 the price of copper was 73 cents per pound.

B. NONMETALLIC MINERAL RESOURCES

1. Known Mineral Deposits

There is a gypsum deposit named the Robb near Galt on the west side of Meadow Valley Wash (see Nonmetallic Land Classification and Occurrence Map). This is the deposit which Tschanz and Pampeyan (1970) refers to as being one of the best deposits in Lincoln County. It is in the Permian red beds being about 2,600 feet long and 1,000 feet wide with individual gypsum beds dipping steeply and ranging in thickness from inches to 20 feet. This deposit is outside the boundary of the included WSA. It is inside the adjacent WSA, WSA NV 050-0156, in the Meadow Valley Mountains GRA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

There is a vermiculite prospect on the west flank of the Mormon Mountains, approximately in Sec. 24 of T 11 S, R 67 E, which is presumably the prospects shown on the Rox NE 7.5-minute topographic sheet. It is on a 30- to 40-foot thick layer of altered biotite schist between two minor pegmatite dikes in Precambrian rocks (Tschanz and Pampeyan, 1970). A visit to the site during the field verification confirmed the presence of small prospects in Precambrian pegmatite, but we could not confirm the presence of vermiculite. What appeared to be mica, however, was present and could be the vermiculite referred to. The pegmatite resembled more a coarse-grained granite and no other typically pegmatitic minerals like tourmaline or beryl wer observed.

Thin barite veins associated with hematite are found in Precambrian rocks in Sec. 29 of T 11 S, R 69 E in the East Mormon Mountains outside the WSA.

A clay occurrence has been reported 15 miles southeast of Carp, probably in the vicinity of the east Mormon Mountains, but no better location is known. There is reportedly a 55-foot vertical shaft on the deposit. The location of this occurrence should be verified.

There are abundant carbonate rocks in the WSA which could possibly be used in cement and lime manufacture.

3. Mining Claims, Leases and Material Sites

There are two lode claims called "Barite" covering the previously mentioned barite occurrence in the East Mormon Mountains. There is one lode claim at the above described vermiculite prospect. The other claims in the GRA are not believed to be for nonmetallic mineral commodities.

There are no known material sites within the WSA, but the abundance of alluvial material derived from the mostly carbonate rocks of the Mormon Mountains would indicate that good quality sand and gravel is probably present.

4. Mineral Deposit Types

The barite is a vein deposit in Precambrian rocks. The vermiculite is in altered Precambrian biotite schist or associated pegmatites. The clay is of unknown origin and the gypsum is an evaporite deposit in the Permian red beds.

5. Mineral Economics

It is unlikely that any of the described nonmetallic resources as outlined in the literature or as field verified is currently economical. Additional work would be needed to more accurately determine their viability.

Vermiculite is a mica-like mineral that has the peculiar property of exfoliating -- expanding greatly by separating on the individual microscopically-thin layers -- when heated. Its principal use is as lightweight aggregate in concrete where acoustic and thermal insulation are desired characteristics. Other uses are as loose-fill insulation in structures, as insulating bedding or covering for molten metal or hot metal ingots and hot chemical pipelines, as an agricultural soil conditioner or plant-growing medium, in water purification and as a filler in paints and plastics. The United States uses about 350,000 tons per year, and produces just about this quantity, although a small tonnage is exported and an equally small tonnage is imported. The United States has half of the world's known vermiculite reserves and the Republic of South Africa has most of the remaining reserves. United

States consumption is forecast to about double by the year 2000, with domestic production keeping up with demand. The price of exfoliated vermiculite is about $60 per ton.

More than 90% of all barite mined is used to make mud for oil and gas well drilling, where the high specific gravity, softness and chemical inertness of the mineral are essential characteristics. Other uses of barite are in barium chemicals that have a wide variety of applications. In recent years the United States has used nearly three million tons of barite annually; usage fluctuates with oil and gas drilling activity. Domestic sources produced about two-thirds of the barite used, with Nevada being by far the largest producer. Most imported barite is used in the states near the Gulf of Mexico, where shipping costs by sea from foreign sources are lower than rail transportation costs from Nevada. Barite consumption in the United States is forecast to be about the same in the year 2000 as it presently is, although this will depend largely on oil and gas drilling activity and the forecast may be greatly in error. Domestic production is expected to continue to satisfy about two-thirds of the demand. The price for crude barite is about $25 per ton, while crushed and ground barite ready for use as drilling mud is about $50 per ton.

The most common use of sand and gravel is as "aggregate" -- as part of a mixture with cement to form concrete. The second largest use is as road base or fill. About 97 per cent of all sand and gravel used in the United States is in these applications in the construction industry. The remaining three percent is used for glassmaking, foundry sands, abrasives, filters and similar applications. The United States uses nearly one billion tons of sand and gravel annually, all of it produced domestically except for a very small tonnage of sand that is imported for highly specialized uses. Since construction is by far the greatest user of sand and gravel, the largest production is near sites of intensive construction, usually metropolitan areas. Since sand and gravel are extremely common nearly everywhere, the price is generally very low and mines are very close to the point of consumption -- within a few miles as a rule. However, for some applications such as high-quality concrete there are quite high specifications for sand and gravel, and acceptable material must be hauled twenty miles and more. Demand for sand and gravel fluctuates with activity in the construction industry, and is relatively low during the recession of the early 1980s. Demand is expected to increase by about one-third by the year 2000. In the early 1980's the price of sand and gravel F.O.B. plant averaged about $2.50 per ton, but varied widely depending upon quality and to some extent upon location.

Pure limestone and dolomite are used principally to produce lime, but some is used as rock for building stone, crushed rock, and similar applications. The principal uses of lime are in steel smelting, water purification, as an alkali, in paper and pulp manufacture, and sewage treatment. Other uses for lime are in sugar purification, mortar, and as an agricultural soil conditioner. Limestone with certain clay impurities (called cement rock), or purer limestone with clay added, is used to make cement that is mostly consumed in construction. The United States uses about 20 million tons of lime and 85 million tons of cement annually. For both lime and cement the raw material must be mined within a very few miles of the processing plant, because it has a very low value in the form of run-of-mine rock -- two or three dollars per ton. There are numerous lime and cement plants in the United States, and most of them sell most of their product within a 200 mile radius of the plant. Some cement is imported in the form of clinker, which is the kiln-fired rock that is then ground in the United States. In the early 1980's the price FOB plant of both lime and cement is about $40 per ton.

C. ENERGY RESOURCES

Uranium and Thorium Resources

1. Known Mineral Deposits

There are no known uranium or thorium deposits within or near the GRA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

There are no known uranium or thorium prospects or occurrences within or near the GRA.

3. Mining Claims

There are no known uranium or thorium claims or leases within the GRA.

4. Mineral Deposit Types

The lack of known radioactive mineral occurrences prevents a discussion of deposit types.

5. Mineral Economics

Uranium and thorium would appear to be of little economic value within the GRA as there are no known deposits in the area.

Uranium in its enriched form is used primarily as fuel for nuclear reactors, with lesser amounts being used in the manufacture of atomic weaposn and materials which are used for medical radiation treatments. Annual western world production of uranium concentrates totaled approximately 57,000 tons in 1981, and the United States was responsible for about 30 percent of this total, making the United States the largest single producer of uranium (American Bureau of Metal Statistics, 1982). The United States ranks second behind Australia in uranium resources based on a production cost of $25/pound or less. United States uranium demand is growing at a much slower rate than was forecast in the late 1970s, because the number of new reactors scheduled for construction has declined sharply since the accident at the Three Mile Island Nuclear Plant in March, 1979. Current and future supplies were seen to exceed future demand by a significant margin and spot prices of uranium fell from $40/pound to $25/pound from January, 1980 to January, 1981 (Mining Journal, July 24, 1981). At present the outlook for the United States uranium industry is bleak. Low prices and overproduction in the industry have resulted in the closures of numerous uranium mines and mills and reduced production at properties which have remained in operation. The price of uranium at the end of 1982 was $19.75/pound of concentrate.

Oil and Gas Resources

1. Known Oil and Gas Deposits

There are no known oil and gas deposits in the GRA.

2. Known Prospects, Oil and Gas Occurrences and Petroliferous Areas

There are no known prospects, oil and gas seeps or shows in the GRA or immediate region. The GRA is situated in the petroliferous Paleozoic miogeosyncline province of the Basin and Range. Approximately three miles west of the GRA (off map) Texaco Inc. completed the Federal No. 1 at a depth of 7,030 feet in 1972 (Garside and others, 1977). There were no shows of oil or gas reported (Nevada Bureau of Mines and Geology, Oil and Gas Files, 1982).

3. Oil and Gas Leases

Nearly all of the GRA has been leased for oil and gas.

4. Oil and Gas Deposit Types

Oil deposits that have been found and developed, and those that are bing explored for in the Basin and Range to date, have been limited to the Upper Paleozoic section of the miogeosyncline and the Tertiary section of the intermontane basins. The source rocks are assumed to be in Paleozoic horizons, such as the Mississippian Chainman Shale, and perhaps also the Tertiary section.

The reservoirs at the Trap Spring and Eagle Springs oil fields in Railroad Valley, are the Oligocene Garrett Ranch volcanics or equivalent, which produce from fracture porosity; or the Eocene Sheep Pass Formation, a freshwater limestone. Minor production has been recorded from the Ely(?) Formation of Pennsylvania age at Eagle Springs. It may be that production also comes from other units in the Tertiary or Paleozoic sections in the Blackburn oil field in Pine Valley or the Currant and Bacon Flat oil fields in Railroad Valley.

The GRA is within or close to the North American Overthrust Belt which has good oil and gas production in Wyoming/Utah, Mexico and Canada (Oil and Gas Jour., May 12, 1980). The Federal leases in Nevada are for rank wildcat acreage, and surficial stratigraphic units do not necessarily have a direct bearing on possible drilling objectives at depth, considering overthrust structural implications.

Recent seismic surveys (e.g., Seisdata Services, 1981; Geophysical Service Inc., 1981; GeoData, 1981: Index maps in GRA File) indicate, in part, the general area of industry interest. This and certain other data may be purchased, but deep exploratory test data are not readily available. Published maps of the Overthrust Belt in Nevada are very generalized, and are not necessarily in agreement because exploration is at an early stage (Oil and Gas Jour., May 12, 1980; Western Oil Reporter, June, 1980; Keith, 1979: Index maps in GRA File).

5. Oil and Gas Economics

The low level of production from Nevada Basin and Range oil fields, which are remote from existing pipelines, existing refineries and consuming areas, necessitates the trucking of the crude oil to existing refineries in Utah, California and Nevada. Since the discovery of oil in Nevada in 1953, the level of production has fluctuated.

Factors which have affected the production from individual wells are: reservoir and oil characteristics; Federal regulations; productivity; environmental constraints; willingness or ability of a refiner to take certain types of oil; and of course, the price to the producer, which is tied to regional, national an international prices.

Geothermal Resources

1. Known Geothermal Deposits

   There are no known geothermal deposits in the GRA or surrounding valleys.

2. Known Prospects, Geothermal Occurrences, and Geothermal Areas

   There are no known prospects or occurrences in the GRA, but it is located in a part of the Basin and Range province that has shallow, often high-volume, low-temperature resources.

3. Geothermal Leases

   There are no geothermal leases in the GRA or the region around it.

4. Geothermal Deposit Types

   Geothermal resources are hot water and/or steam which occurs in subsurface reservoirs or at the surface as springs. The temperature of a resource may be about 70°F (or just above average ambient air temperature) to well above 400°F in the Basin and Range province.

   The reservoirs may be individual faults, intricate fault-fracture systems, or rock units having intergranular permeability -- or a combination of these. Deep-seated normal faults are believed to be the main conduits for the thermal waters rising from thousands of feet below in the earth's crust.

   The higher temperature and larger capacity resources in the Basin and Range are generally hydrothermal convective systems. The lower temperature reservoirs may be individual faults bearing thermal water or lower pressured, permeable rock units fed by faults or fault systems. Reservoirs are present from the surface to over 10,000 feet in depth.

5. Geothermal Economics

Geothermal resources are utilized in the form of hot water or steam normally captured by means of drilling wells to a depth of a few feet to over 10,000 feet in depth. The fluid temperature, sustained flow rate and water chemistry characteristics of a geothermal reservoir determine the depth to which it will be economically feasible to drill and develop each site.

Higher temperature resources (above 350°F) are currently being used to generate electrical power in Utah and California, and in a number of foreign countries. As fuel costs rise and technology improves, the lower temperature limit for power will decrease appreciably -- especially for remote sites.

All thermal waters can be beneficially used in some way, including fish farming (68°F), warm water for year around mining in cold climates (86°F), residential space heating (122°F), greenhouses by space heating (176°F), drying of vegetables (212°F), extraction of salts by evaporation and cyrstalization (266°F), and drying of diatomaceous earth (338°F).These are only a few examples.

Unlike most mineral commodities remoteness of resource location is not a drawback. Domestic and commercial use of natural thermal springs and shallow wells in the Basin and Range province is a historical fact for over 100 years.

Development and maintenance of a resource for beneficial use may mean no dollars or hundreds of millions of dollars, depending on the resource characteristics, the end use and the intensity or level of use.

D. OTHER GEOLOGICAL RESOURCES

There is a cave in Sec. 3 of T 11 S, R 67 E. The Mormon Mountains is sometimes regarded as having spectacular relief and extraordinary scenic vistas in the towering limestone cliffs. No other geological resources are known in the GRA. Coal is not known in the GRA, and there is no known potential for coal, oil shale or tar sands.

E. STRATEGIC AND CRITICAL MINERALS AND METALS

A list of strategic and critical minerals and metals provided by the BLM was used as a guideline for the discussion of strategic and critical materials in this report.

The Stockpile Report to the Congress, October 1981 - March 1982, states that the term "strategic and critical materials" refers to materials that would be needed to supply the industrial, military and essential civilian needs of the United States during a national emergency and are not found or produced in the United States in sufficient quantities to meet such need. The report does not define a distinction between strategic and critical minerals.

Copper, tungsten and manganese which are critical and strategic minerals are reported to occur in the GRA. Sixty tons of the manganese was reportedly mined in 1929. Copper is the only strategic and critical mineral occurrence within the WSA, however, at the Whitmore mine previously described.

IV. LAND CLASSIFICATION FOR G-E-M RESOURCES

The geologic maps which cover the WSA include Tschanz and Pampeyan, 1970, and Howard, 1978, both at a scale of 1:250,000 and both essentially the same for the Mormon Mountains. The very southern portion of the WSA is in Clark County and therefore covered by Longwell and others, 1965, at a similar scale. The scale of these geologic maps is too small to show much detail and areas of alteration, if present, are not included. The majority of the data on mineral occurrence came from Tschanz and Pampeyan, 1970, and is very minimal. Overall the quantity of data both geologically and with regard to mineralization or potential mineralization is lacking to adequately assess the mineral potential of the Mormon Mountains. The quality of the data which was used for this report, however, is considered good.

Land classification areas are numbered starting with the number 1 in each category of resources. Metallic mineral land classification areas have the prefix M, e.g., M1-4D. Uranium and thorium areas have the prefix U. Nonmetallic mineral areas have the prefix N. Oil and gas areas have the prefix OG. Geothermal areas have the prefix G. Sodium and potassium areas have the prefix S. The saleable resources are classified under the nonmetallic mineral resource section. Both the Classification Scheme, numbers 1 through 4, and the Level of Confidence Scheme, letters A, B, C, and D, as supplied by the BLM are included as attachments to this report. These schemes were used as strict guidelines in developing the mineral classification areas used in this report.

Land classifications have been made here only for the areas that encompass segments of the WSA. Where data outside a WSA has been used in establishing a classification area within a WSA, then at least a part of the surrounding area may also be included for clarification. The classified areas are shown on the 1:250,000 mylars or the prints of those that accompany each copy of this report.

In connection with nonmetallic mineral classification, it should be noted that in all instances areas mapped as alluvium are classified as having moderate favorability for sand and gravel, with moderate confidence, since alluvium is by definition sand and gravel. All areas mapped as principally limestone or dolomite have a similar classification since these rocks are usable for cement or lime production. All areas mapped as other rock, if they do not have specific reason for a different classification, are classified as having low favorability, with low confidence, for nonmetallic mineral potential, since any mineral material can at least be used in construction applications.

1. LOCATABLE RESOURCES

a. Metallic Minerals

WSA NV 050-0161

M1-3C. This classification area is one of moderate favorability with a moderate confidence level and includes the window of lower plate Precambrian and Cambrian rocks in the vicinity of the Whitmore mine. Several workings found along the apparent thrust contact have evidence of mineralization. Prospects are also found in the Cambrian section in the window. The classification 3C is because there are prospects, evidence of mineralization and alteration, and old claims in the area. In addition a tungsten prospect occurs in the East Mormons in Precambrian pegmatites similar to the pegmatites found here.

M2-3B. This classification area of moderate favorability includes the area of the Iron Blossom lode claims where aerial photo interpretation indicated old workings and possible alteration. This area was not field verified and no other information is known about the claims, hence the B, or low confidence level.

M3-2A. This classification area is considered to have a low favorability with a very low confidence level and is located in the lower plate window of the thrust on the western edge of the Mormon Mountains. The classification of 2 is because these Lower Paleozoic rocks do show mineralization in other areas where exposures occur in Lincoln County, including one area in the Mormon Mountains just a few miles to the east (classification area M1-3C). The confidence level A is because no evidence of metallic mineralization is known in this area. A tungsten prospect, however, occurs in these same rocks in the east Mormon Mountains outside the WSA boundary but still within the GRA.

M4-2B. This classification area is considered to have low favorability with a low confidence level and includes all the remaining Paleozoic rocks in the WSA. This classification includes the majority of the outcrop area of the Mormon Mountains. The low favorability is because elsewhere in the region similar rocks show mineralization. In addition the thrust surface underlying these rocks is in contact with older rocks the character of which is unknown; and within the Mormon Mountains this thrust surface is associated with some alteration and mineralization. The B confidence level is due to the known mineralization at places along the buried thrust outside this classification area which is considered to be indirect evidence of mineralization at depth along the thrust surface in this classification area.

M5-2B. This classification area of low favorability with a low confidence level includes the areas of volcanic outcrops in the northern portion of the WSA. They are considered to have low favorability because: these volcanics overlie the previously described upper plate Paleozoic rocks which are classified as 2B; and secondly, similar volcanic rocks on the Iron Blossom lode claims (classification area M2-3B) may be associated with minor alteration or mineralizaton.

M6-2A. This classification area includes all the alluvium in the northern two-thirds of the WSA. The low favorability classification with a very low confidence level is because there is no evidence of mineralization but the nature of the underlying bedrock is unknown. The adjacent outcrop areas are classified as having a 2 favorability, hence these same units beneath the alluvium also have the same potential but there is no direct evidence to support this.

M7-2B. This classification area is one of low favorability with a low confidence level and includes the alluvium in the southern portion of the WSA which is covered by placer claims. Rumor has it that these claims are for precious metals. No known geological evidence exists to suggest a higher favorability than what has previously described above under classification M6-2A. The increase to a B confidence level is solely based on the presence of the claims. This area needs further verification.

b. Uranium and Thorium

WSA 050-0161

U1-2B. This land classification covers most of the WSA, indicating low favorability for uranium concentration, at a low confidence level. Vein-type and fracture-fill uranium deposits are prospective in the area and could occur in any of the rock formations of the Mormon Mountains, particularly along the numerous fracture zones. Sources for the uranium could be the underlying Precambrian granites and pegmatites or the Tertiary volcanics which once overlaid much of the area and are still present in the northern part of the WSA.

Thorium has very low favorability for concentration in the area, at a very low level of confidence. It could possibly form small deposits in the underlying Precambrian pegmatites.

U2-2B. This land classification covers the border areas around the WSA where Quaternary and Tertiary alluvial sediments are present. The area has low favorability with

low confidence for epigenetic sandstone-type uranium deposits. Uranium could have been leached by ground water from the Mormon Mountains, carried down into the alluvium, and deposited along permeable horizons in the alluvium.

The area has very low favorability for thorium deposits with a very low level of confidence.

The only prospective source for the thorium would be the Precambrian granites and pegmatites. Since these rocks are overlain by Paleozoic sediments it is doubtful that they would have undergone sufficient erosion to allow resistate mineral (i.e., monazite sands) concentrations in the surrounding alluvium.

c. Nonmetallic Minerals

WSA NV 050-0161

N1-3C. This classification area of moderately favorability with a moderate confidence level includes the Precambrian rock on the west flank of the Mormon Mountains. This unit contains numerous pegmatite phases and here is where the vermiculite prospects are. The pegmatite in the small thrust window near the Whitmore mine is also included as field checking both areas indicated the units were very similar. These pegmatites contain not only possible vermiculite, but the field reconnaissance indicated that the coarse-grained pegmatites contain abundant feldspar, quartz and mica. More detailed evaluation would be necessary in order to more specifically identify the pegmatite potential.

N2-3C. This area of moderate favorability with a moderate confidence level includes all the outcrop areas of the Prospect Mountain Quartzite. The quartzite could possibly be used for silica sand even though the economics of this utilization in the Mormon Mountains at the present time make such a possibility very remote.

N3-3C. The classification area of moderate favorability with a moderate confidence level includes all the upper plate Paleozoic carbonate rocks exposed in the WSA. This area shows moderate favorability because these carbonate units could probably be utilized in cement or lime manufacture.

N4-2B. This classification is one of low favorability with a low confidence level and includes all the outcrop areas of Tertiary volcanic rocks in the WSA. These volcanics are mapped as undivided on the Lincoln County geologic map and may be similar to those to the west and north which are known to contain perlite. At any rate any

rock can be utilized for at least construction application hence the no lower than 2B classification.

N5-3C. This classification area covers all the alluvium within the WSA. This material could probably be utilized as sand and gravel in various nearby construction applications. The Mormon Mountains are primarily carbonates and the source for the alluvium, therefore the quality of the sand and gravel present may be good.

2. LEASABLE RESOURCES

a. Oil and Gas

WSA NV 050-0161

OG1-3A. This classification covers that portion of the WSA that has the Pennsylvanian/Permian miogeosyncline sediments, Tertiary volcanics and valley fill in outcrop. It is assumed that there could be a sufficient prospective stratigraphic section for the generation and entrapment of hydrocarbons.

This WSA is regarded as being within the prospective Overthrust Belt. The density of leasing is indicative of industry's interest in the entire WSA.

OG2-2A. This portion of the WSA is underlain by undifferentiated Cambrian-Devonian age rocks, mostly carbonate, which are overlain by remnants of Mississippian limestones. This section is stratigraphically lower than the units deemed most prospective in this region.

There may also be a play at depth, if in fact, this is part of the Overthrust.

b. Geothermal

WSA NV 050-0161

G1-2A. There are numerous known and probably very large, deep-seated, normal faults throughout the WSA. These faults are the type which often act as conduits for rising thermal waters. The paucity of drilling of any kind in the WSA area may be the reason why no low-temperature resources have been encountered.

c. Sodium and Potassium

WSA NV 050-0161

S1-1C. This classification applies to the entire WSA. There is no indication of favorability with a high confidence level for the accumulation of resources of sodium and potassium. There is no classification map for this commodity.

3. SALEABLE RESOURCES

The saleable resources, sand and gravel, have been discussed above under nonmetallics and include area N5-3C.

V. RECOMMENDATIONS FOR ADDITIONAL WORK

1. A detailed geological mapping program should be undertaken to more adequately define mineral resource potential. Additional mapping at a larger scale would certainly help to better evaluate the vermiculite or other nonmetallic occurrences in the pegmatites, the Whitmore mine area and the Iron Blossom claims area.

2. A large number of placer claims are found within the southern boundary of the WSA. These should be investigated further to determine the presence of mineral resources.

3. The location of the clay deposit reported 15 miles southeast of Carp should be verified.

VI. REFERENCES AND SELECTED BIBLIOGRAPHY

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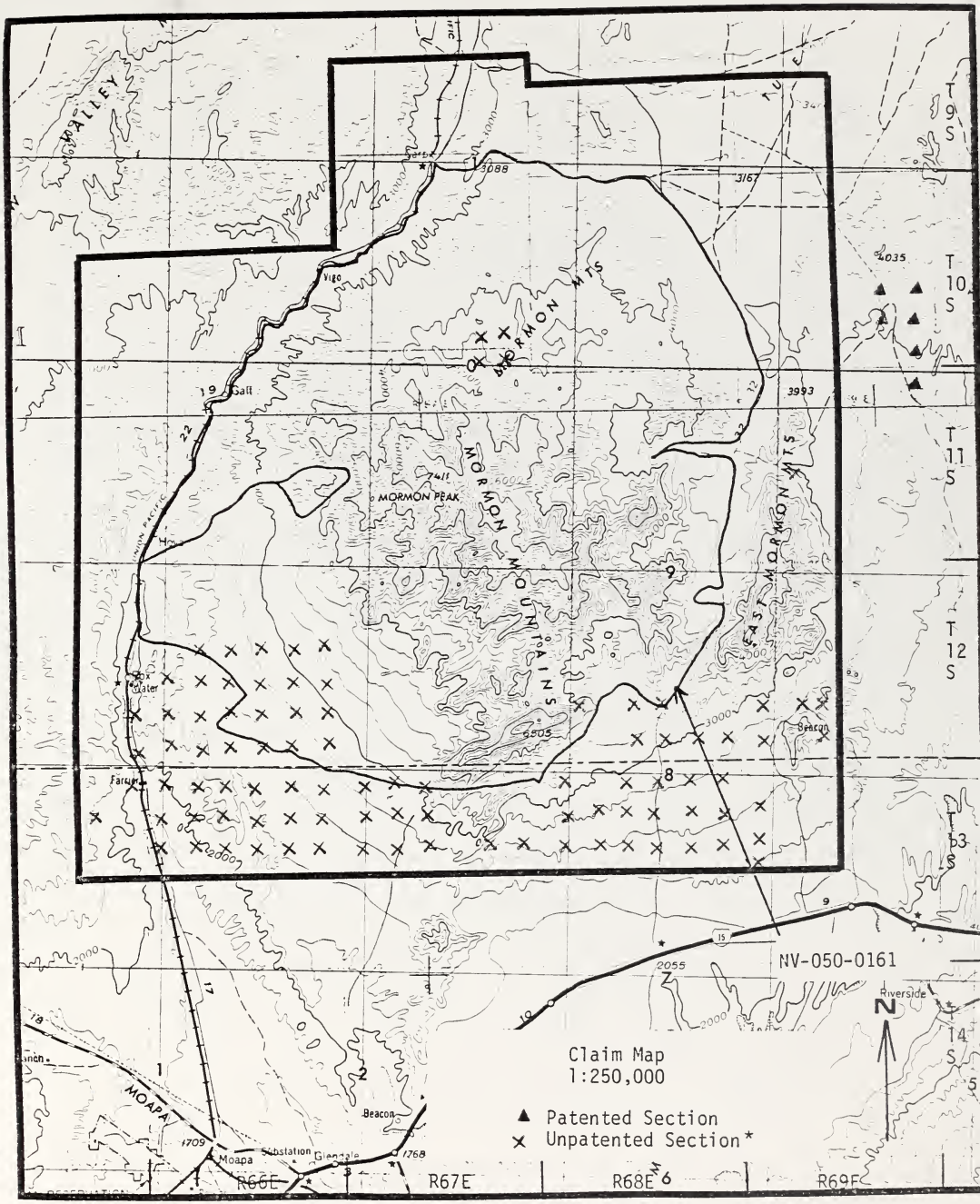
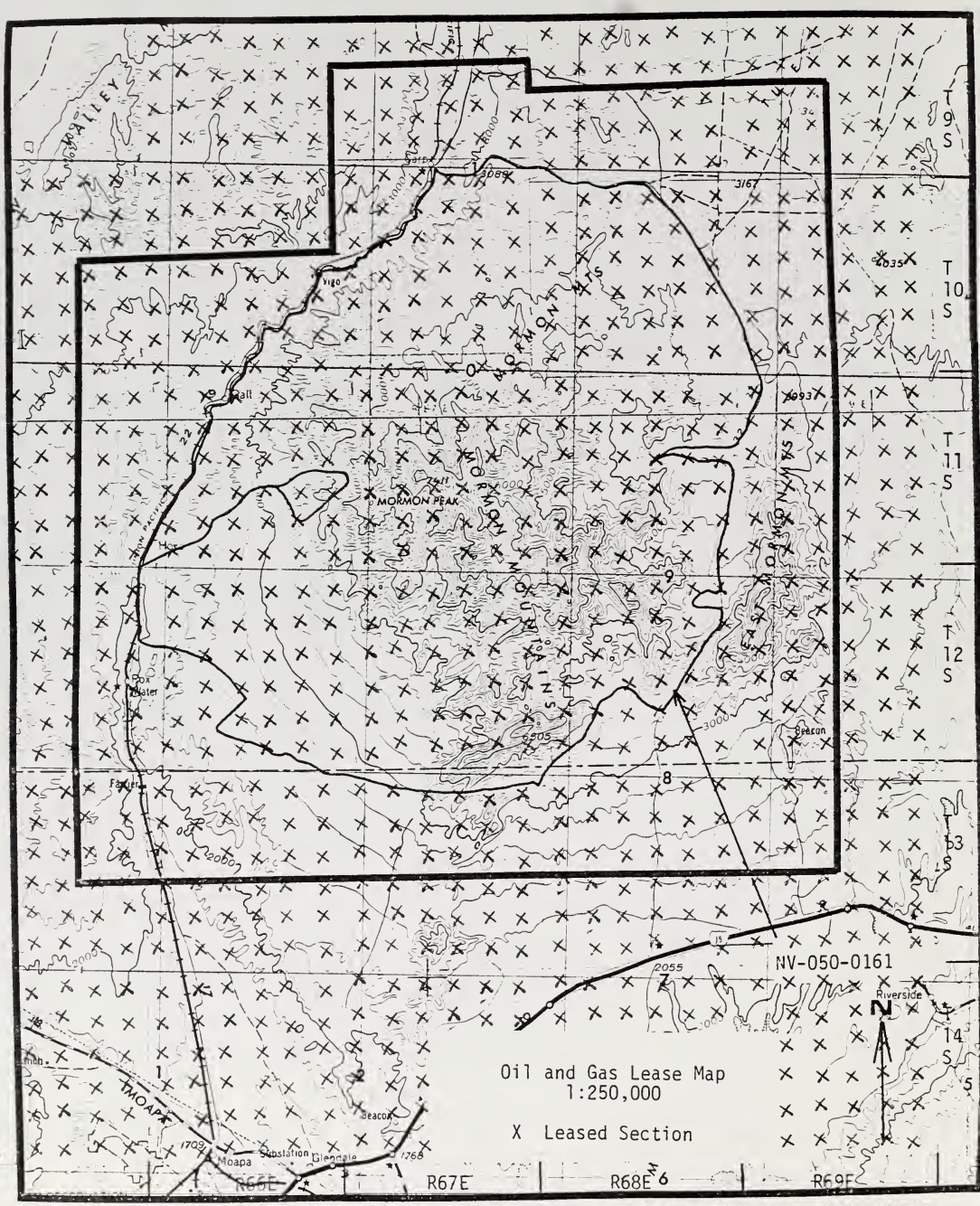


*X denote one or more claims per section

Mormon Mountains GRA NV-27



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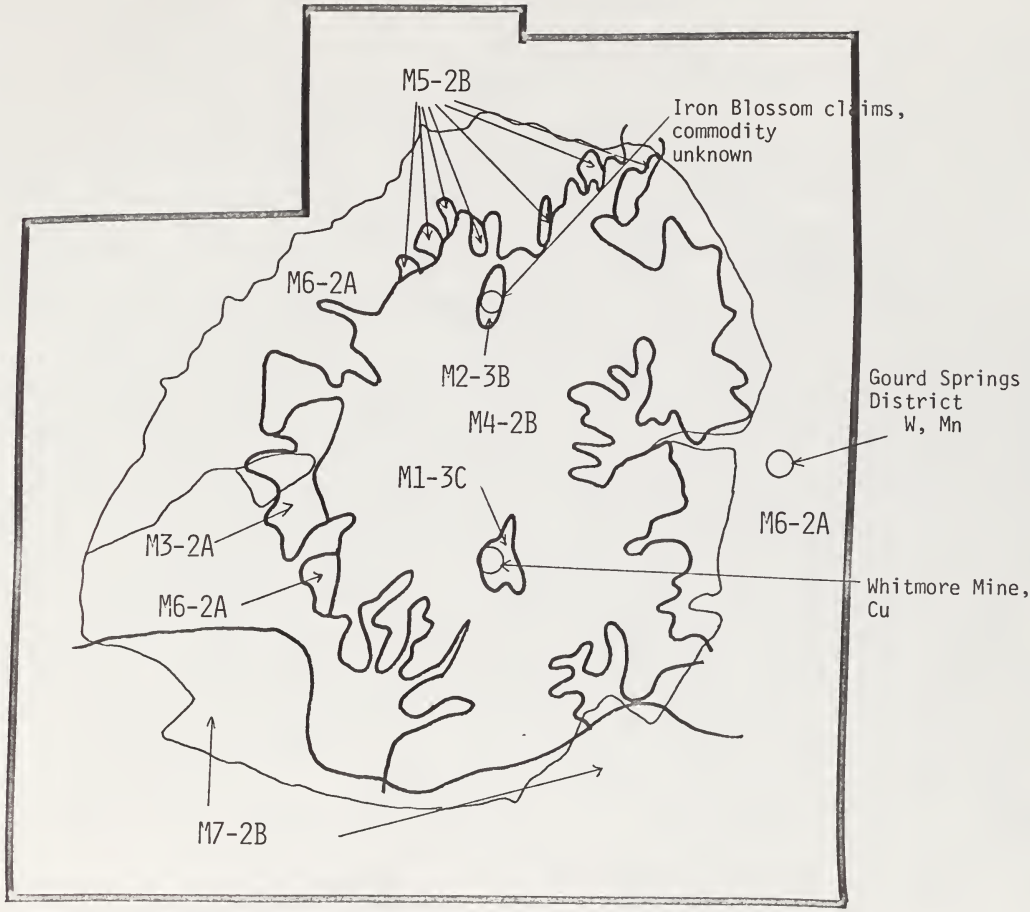


EXPLANATION

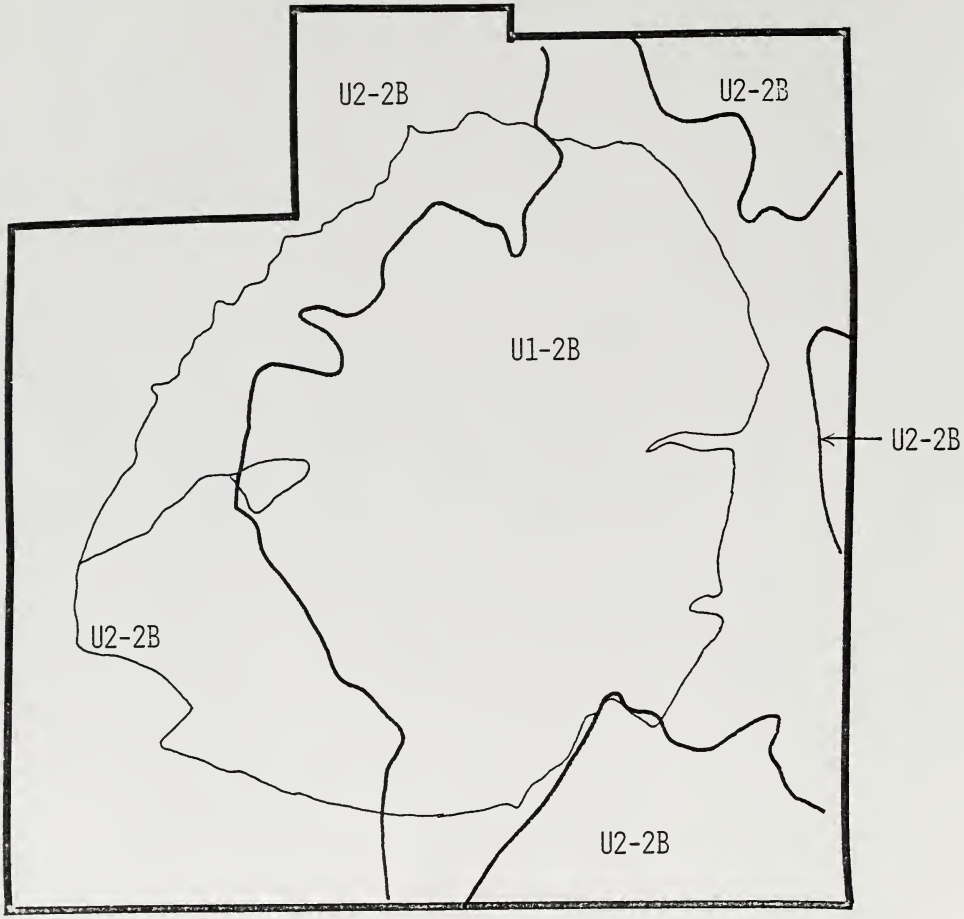
Occurrence, commodity

Land Classification Boundary

WSA Boundary

Mormon Mountains GRA NV-27
Scale 1:250,000

Land Classification and Mineral Occurrence Map/Metallics

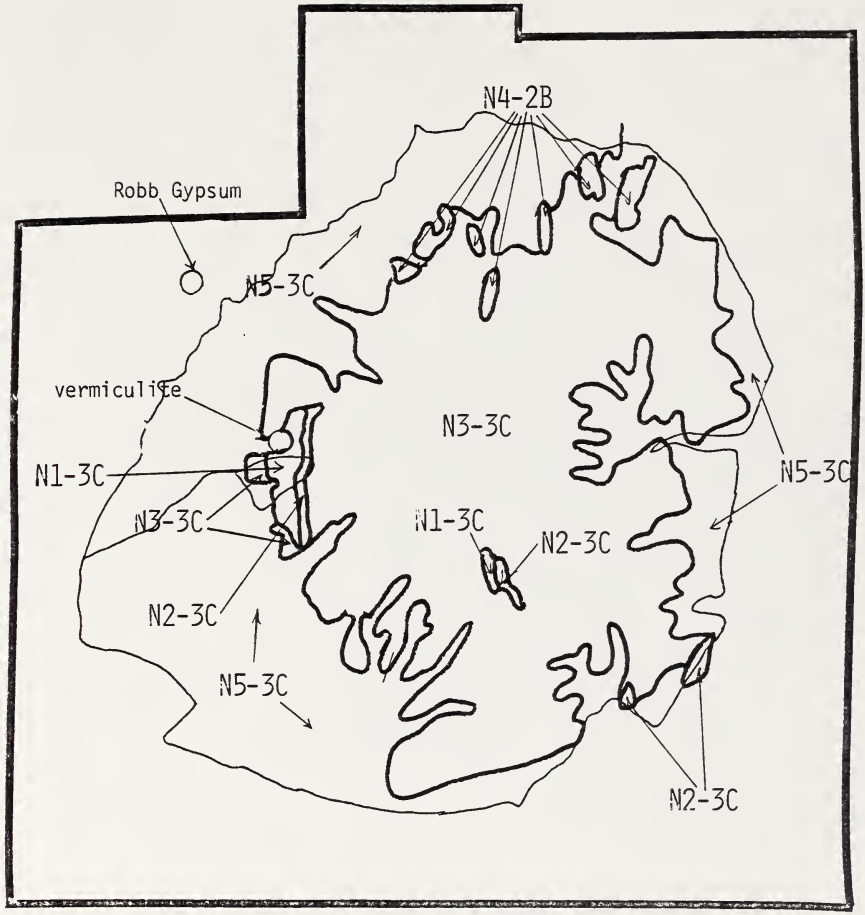


EXPLANATION

Land Classification Boundary

WSA Boundary

Land Classification and Mineral Occurrence Map/Uranium Mormon Mountains GRA NV-27
Scale 1:250,000



EXPLANATION

- Occurrence, commodity
- Land Classification Boundary
- WSA Boundary

Land Classification and Mineral Occurrence Map/Nonmetallics Mormon Mountains GRA NV-27
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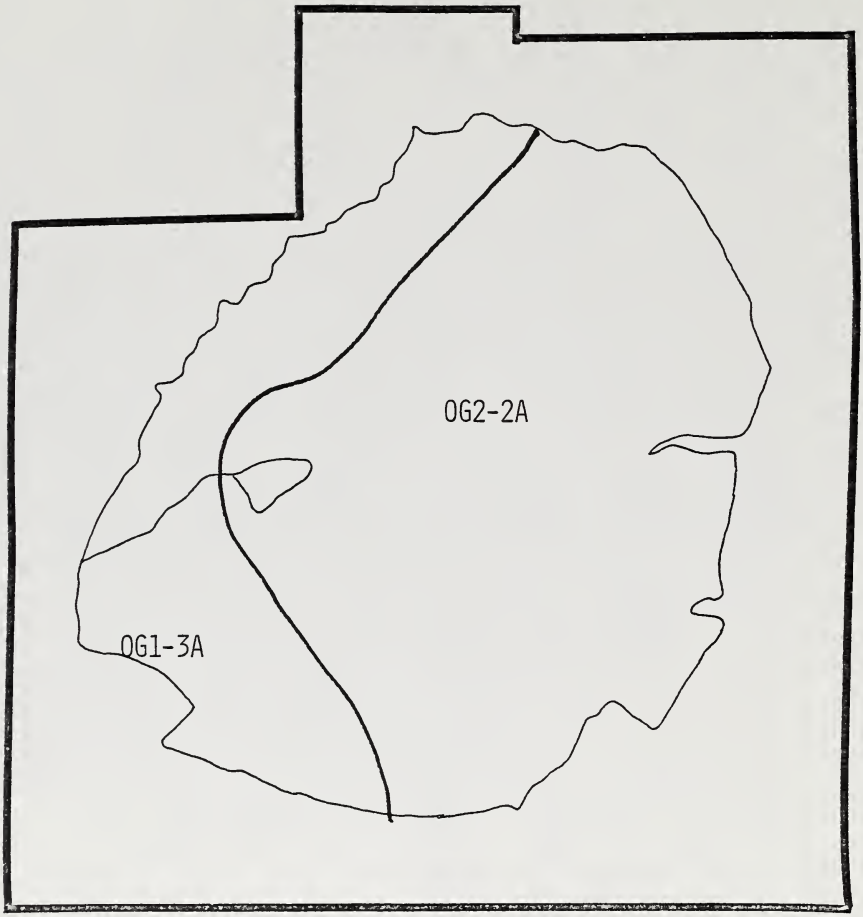


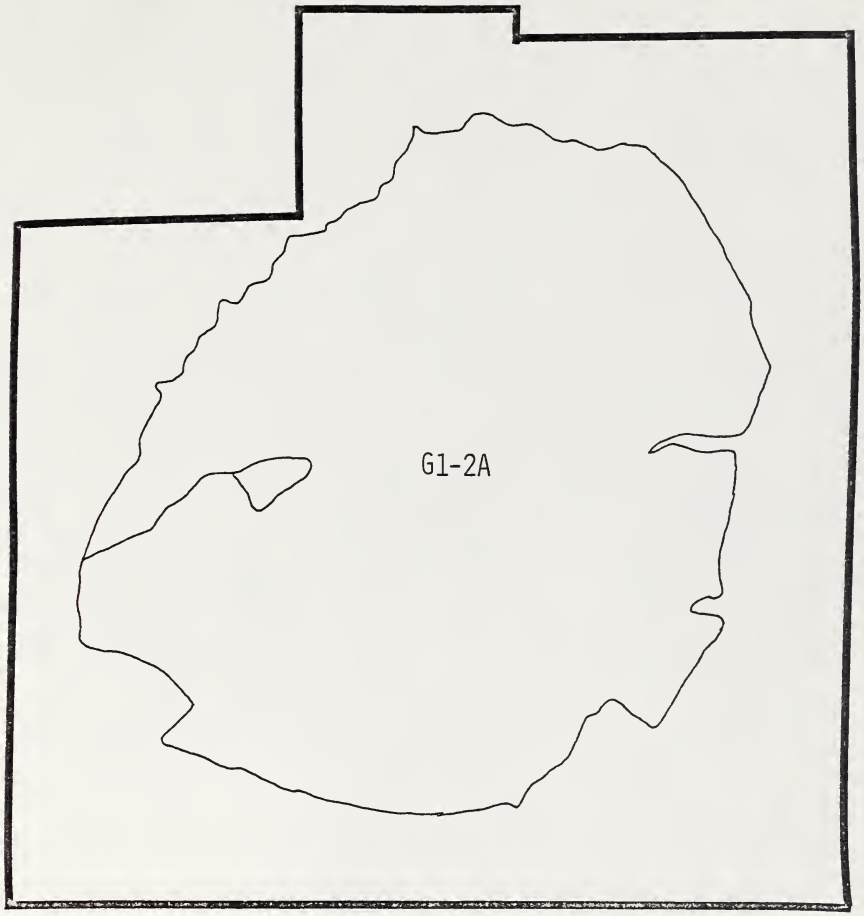
EXPLANATION

—— WSA Boundary

━━ Land Classification Boundary

Land Classification - Mineral Occurrence Map/
Oil and Gas

Mormon Mountains GRA NV-27
Scale 1:250,000



EXPLANATION

—— WSA and Land Classification Boundary

Mormon Mountains GRA NV-27
Scale 1:250,000

Land Classification - Mineral Occurrence Map/Geothermal

LEVEL OF CONFIDENCE SCHEME

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVELY MINIMAL TO SUPPORT TO REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

MAJOR STRATIGRAPHIC AND TIME DIVISIONS IN USE BY THE U.S. GEOLOGICAL SURVEY

Erathem or Era	System or Period	Series or Epoch	Estimated ages of time boundaries in millions of years
Cenozoic	Quaternary	Holocene	
		Pleistocene	2-3 [1]
	Tertiary	Pliocene	12 [1]
		Miocene	26 [2]
		Oligocene	37-38
		Eocene	53-54
		Paleocene	65
Mesozoic	Cretaceous [4]	Upper (Late) Lower (Early)	136
	Jurassic	Upper (Late) Middle (Middle) Lower (Early)	190-195
	Triassic	Upper (Late) Middle (Middle) Lower (Early)	225
Paleozoic	Permian [4]	Upper (Late) Lower (Early)	280
	Carboniferous Systems: Pennsylvanian [4]	Upper (Late) Middle (Middle) Lower (Early)	
	Carboniferous Systems: Mississippian [4]	Upper (Late) Lower (Early)	345
	Devonian	Upper (Late) Middle (Middle) Lower (Early)	395
	Silurian [4]	Upper (Late) Middle (Middle) Lower (Early)	430-440
	Ordovician [4]	Upper (Late) Middle (Middle) Lower (Early)	500
	Cambrian [4]	Upper (Late) Middle (Middle) Lower (Early)	570
Precambrian [3]		Informal subdivisions such as upper, middle, and lower, or upper and lower, or younger and older may be used locally.	3,600+ [3]

[1] Holmes, Arthur, 1965, Principles of physical geology: 2d ed., New York, Ronald Press, p. 360-361, for the Pleistocene and Pliocene; and Obradovich, J. D., 1965, Age of marine Pleistocene of California: Am. Assoc. Petroleum Geologists, v. 49, no. 7, p. 1057, for the Pleistocene of southern California.

[2] Geological Society of London, 1964, The Phanerozoic timescale; a symposium: Geol. Soc. London, Quart. Jour., v. 120, supp., p. 260-262, for the Miocene through the Cambrian.

[3] Stern, T. W., written commun., 1968, for the Precambrian.

[4] Includes provincial series accepted for use in U.S. Geological Survey reports.

Terms designating time are in parentheses. Informal time terms early, middle, and late may be used for the eras, and for periods where there is no formal subdivision into Early, Middle, and Late, and for epochs. Informal rock terms lower, middle, and upper may be used where there is no formal subdivision of a system or of a series.

GEOLOGIC NAMES COMMITTEE, 1970